Name: **Id#**

COE 202, Term 162
Fundamentals of Computer Engineering

Quiz# 4 Solution

Date: Sunday, April 16

Q1. In designing a combinational circuit that computes the function $f(X) = X^2 - X$ for a 3-bit 2's complement signed number X, ***where the output f(X) is an un-signed integer*:**

(i) How many bits do we need for the output? [2 points]

X that produces that largest f(x) is -4. In this case f(x) = 16+4 = 20. So, the number of bit needed for the output is 5 bits.

(ii) Obtain the truth table for this circuit. [4 points]

X_2 X_1 X_0	Decimal value of X	Decimal value of f(X)	F_4 F_3 F_2 F_1 F_0
0 0 0	0	0	0 0 0 0 0
0 0 1	+1	0	0 0 0 0 0
0 1 0	+2	2	0 0 0 1 0
0 1 1	+3	6	0 0 1 1 0
1 0 0	-4	20	1 0 1 0 0
1 0 1	-3	12	0 1 1 0 0
1 1 0	-2	6	0 0 1 1 0
1 1 1	-1	2	0 0 0 1 0

(iii) Obtain simplified Boolean expressions of the circuit outputs in SOP form. [4 points]

F_4 F_3 F_1 F_0 Can be obtained directly from the truth table (no minimization can be done)

$F_4 = X_2 X_1' X_0'$

$F_3 = X_2 X_1' X_0$

$F_1 = X_1$

$F_0 = 0$

K-map for F_2:

$F_2 = X_2' X_1 X_0 + X_2 X_1' + X_2 X_0'$

		X_1'			
		00	01	11	10
X_2'	0	0	0	1	0
	1	1	1	0	1

Q2.

(i) What is the **minimum** number of bits needed to represent integers in the range from –100 to +100 using sign-magnitude representation? [2 points]

8-bits

(ii) Show the binary representations of **+49** and **–49** using **10-bits** signed-magnitude, 1's complement and 2's complement representations (record your answers in the table below). [4 points]

Decimal	Binary Signed-magnitude representation	Binary Signed-1's complement representation	Binary Signed-2's complement representation
- 49	**1_000_110_001**	**1_111_001_110**	**1_111_001_111**
+ 49	**0_000_110_001**	**0_000_110_001**	**0_000_110_001**

(iii) Perform the following operations on **6-bits** signed numbers **using 2'complement representation**. Check for overflow and mark clearly any overflow occurrences. [4 points]

(1) 011100 – 011111	(2) 101111 + 100110
= 011100 + 100001	**= 010101**
= 111101	
Overflow: Yes/**No**	Overflow: **Yes**/No